A STUDY OF POST-FIRE REGENERATION
AT THE OHIO STATE UNIVERSITY
BARNEBEY CENTER

An Honors Project
by

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INTRODUCTION

The purpose of this study was to measure the vegetative response of an upland oak-hickory community to fire and cutting and to relate response of the major regenerating species to the site factors of slope, aspect, and topographic slope position.

Fire is an important factor in forest communities and influences patterns of plant succession. Microclimatic changes following burning influence not only types of species regenerating upon an area but also chances of survival for these organisms throughout their life cycle. It follows that information regarding post-fire reproduction on upland oak-hickory sites may be applicable on the managerial level. This is true especially since the oak-hickory forest is the most extensive timber type in the United States (1). In Ohio alone, despite a well developed protection system, there were 665 fires during the 1974-1975 season which burned a total of 1633 acres (2). A significant percentage of this area was of the oak-hickory cover type.

Studies of post-fire response of upland oak-hickory stands are limited. A possible explanation is that in the majority of cases, fires are neither large enough nor severe enough to immediately alter species composition of ecosystems. Natural regeneration is quickly obtained through stump strouting, seedling sprouting, and through activation of seeds within the duff layer.

Davis (3) claims that environmental changes brought about by fire may be both immediate and long range in nature. It is the complex interaction of both short and long range effects that makes a determination of pyric effects so difficult. Further, in attempting to make such appraisals with respect to a given species, it is necessary to not only study the direct effect on trees at different stages of growth but also the more indirect effects caused by the altered microclimate (4). This study, then, is a superficial look at a stand's immediate reaction to fire. Hopefully, it will serve as a basis for subsequent work relating to more developed vegetational stages and also to more narrowly defined microenvironmental conditions.

AREA OF STUDY

The area of study is located in Fairfield County, Ohio at the Barnebey Center of Ohio State University. This area of land is within the Muskingum-Wellston soil area. Soils were formed from acid sandstone and shale and have gentle to very steep slopes. They are brown, well-drained, medium to strongly acidic, and moderately low in productivity. Generally, drowthy conditions prevail, along with low natural fertility and moderate amounts of organic matter (5). The land on which this study took place had previously been cut over for pasturing of livestock.

On April 20, 1974, a fire swept through approximately 13 acres of upland oak-hickory on a poor to medium site. The cause of this fire is uncertain, but arson is suspected. During May of 1975, about 8 acres of the burned area was clearcut. Yield was approximately 56,000 board feet of sawlogs and 524 tons of pulpwood. After the cut, it was determined that the timber had been between 80 and 100 years old (6).

This particular study was carried out in October of 1975, eighteen months following the fire and five months after the clearcut. The study was restricted to that area common to both the burn and the harvest. Those areas that were burned but not harvested were ignored.

METHODS AND PROCEDURES

The field results are based upon a series of 32, 1/1000 acre circular plots placed two chains apart. The test area was gridded with these milacre plots which were located on north-south transects. The first plot was established one chain due south of the large standing sourwood tree at the northeastern-most point of the clearcut. Continuing in a southerly direction, additional plots were established at two chain intervals. At the last plot to fall within the test area boundary, the transect was shifted one chain to the west, a plot was put in, and the transect was continued in a northerly direction. This pattern was continued until the entire area was covered.

On each of 32 plots, three site characteristics were measured. The topographic slope was determined by averaging Abney measurements taken in the upslope and downslope direction from each plot center. Aspect was determined using a standard hand-help compass and by subjectively evaluating the direction of most rapid water drainage. Topographic slope position, which is the ratio of the total distance upslope of the plot to the overall slope distance, was measured by pacing. The author stood at the highest point immediately upslope of the plot center and walked downhill, through the plot, and ended up at the point of lowest elevation on that transect. All tree regeneration under three feet in height was considered of seedling origin. This was counted and recorded according to species.

The data was then analyzed on subprogram Crosstabs of the Statistical Package for the Social Sciences program. This subprogram is a contingency table analysis which computed and displayed the four, three, and two-way crosstabulation tables for the discrete variables of species, slope, topographic slope position and aspect. The values of the last three of these variables were grouped in order to make analysis of the limited number of trees possible. Slopes of 11 to 16.33 topographic units were classified as "light", those of 16.34 to 21.66 as "moderate", and those from 21.67 to 27 as "steep". Slope position indices from 0.19 to 0.37 were classified as ridgetop positions, those from 0.38 to 0.56 as upslope positions, those from 0.57 to 0.74 as downslope positions, and those from 0.75 to 0.93 as lowland positions. Aspects from 90 to 179 degrees were classified as southeast aspects, those from 180 to 269 degrees as southwest aspects, and those from 270 to 360 as northwest aspects. None of the plots in this study had aspects from 0 to 89 degrees, and thus no analysis was possible for plots with northeast aspects.

Tree frequency distributions were statistically analyzed based on Chi-square tests of significance. The null hypothesis of no relation between species occurrence and a particular site characteristic was accepted if the significance as given by the computer output was greater than 5%.

RESULTS

There appears to be a complex interaction of species type with topographic slope position, depending upon aspect and steepness of slope (Table 1). On all slope steepnesses and aspects where sufficient data was available to make a statistical analysis, species type was significantly correlated with topographic slope position. This significance for the northwest aspect on a light slope was due partly to the fact that there were more tulip (Liriodendron tulipifera) on both lowland and downhill positions than would be expected by random chance, and more chestnut oak (Quercus prinus)on uphill positions than would occur by random chance. On southeast aspects with moderate slopes, there were more tulip than would be expected on both lowland and downhill slope positions while chestnut oak was present in larger numbers than would be expected only on ridgetop positions. For tulip on southeast aspects with steep slopes, there were more than would be expected only on downhill positions, while for chestnut oak there were a greater number of occurrences of this species on both uphill and ridgetop positions than would occur by random chance alone. On southwest aspects with light slopes, there were a limited number of observations, and no statistic was available for uphill positions. Tulip was present in slightly greater numbers than would be expected by chance on both lowland and downhill positions, while chestnut oak was present in slightly greater numbers than would be expected on ridgetops and downhill positions. On southwest aspects with moderate slopes, there was no available data for lowland positions. At slightly higher elevations, on downhill positions, more tulip than would be expected occurred. On uphill positions, there were more chestnut oak than would be expected by random chance alone.

Table 2 shows the significant relationships between species and slope controlling for aspect and slope position. On lowland positions with northwest aspects, this significance is explained in part by the fact that there were more tulip on light slopes and more chestnut oak on moderate slopes than would be expected by random chance alone. There was no data available for steep slopes. Further, sufficient data was not available for any other slope position with northwest aspect.

On southwest aspects there was insufficient data to study species-slope interaction on lowland and uphill positions. This interaction on downhill positions was not significant, while on ridgetop positions, it was significant. This significance is due, in part, to the fact that on steep slopes there was a larger number of chestnut oak seedlings present than could be accounted for by random chance alone. Tulip was represented on all slopes in proportions quite similar to those expected by chance.

On southeast aspects, species-slope interaction was significant only on lowland and uphill positions. In the lowland position, tulip was represented on moderate slopes to a greater extent than would be expected by chance alone. No chestnut oak was sampled on this type of site, and no species were sampled on light slopes. In uphill positions, the significance of species-slope interaction could be attributed to the fact that a larger number of tulip were present on moderate slopes, and a larger number of chestnut oak were present on steep slopes than would be expected from random chance alone.

Species-aspect interactions shown in Table 3 also appear to be complex, with significance depending upon slope and slope position. On light slopes with lowland and downhill slope positions, species-aspect interaction was not significant. Only on ridgetop positions with such slope was this interaction significant. The significant Chi-square value for this interaction was due partly to the fact that there were more tulip on northwest aspects and more chestnut oak on southeast and southwest aspects than could be expected by random chance alone.

On moderate slopes, species-aspect interaction was significant on all four of the possible slope positions. On lowland positions, there was a greater number of tulip on southeast aspects and a greater number of chestnut oak on northwest aspects than could be expected by random chance. This particular crosstabulation table had no observations on southwest aspects and thus only two degrees of freedom for testing the Chi-square value.

On downhill positions with moderate slope, there were a greater number of tulip on southeast aspects and a greater number of chestnut oak on southwest aspects than one could attribute to random chance. Further, there were no observations on northwest aspects and thus only two degrees of freedom with which to test the Chi-square value.

On uphill positions with this same slope, tulip was found in numbers greater than those expected by random chance on southeast aspects. Such was also the case for chestnut oak on southwest aspects. No observations were made on northwest aspects, and thus there were only two degrees of freedom for testing the Chi-square value.

Finally, on ridgetop positions with moderate slopes, there were a larger number of chestnut oak on southeast aspects than would be expected by chance. Tulip, under these same conditions, was represented on both southeast and southwest aspects in numbers greater than would be expected by chance. Again, trees were not observed on northwest aspects, and this crosstabulation analysis had only two degrees of freedom.

On steep slopes, there was insufficient data to determine species-aspect interaction for lowland, downhill and uphill positions. On ridgetops this interaction was significant. A partial reason for such significance is that there were a greater number of chestnut oak on southeast aspects than would be expected by random chance. No species were observed on northwest aspects, and only two degrees of freedom were used to test the Chi-square value.

Tables 4 through 9 represent the results of crosstabulations of a more general order than the previous ones. Table 4 shows the significant species-slope position interactions controlling for aspect but considering all slopes simultaneously. This interaction was found significant on all three aspects. On northwest aspects, there were more tulip on both lowland and uphill positions than would occur by random chance. On southeast aspects, tulip was present in unexpectedly large numbers on downhill positions while chestnut oak was found on ridgetops in larger numbers than would be expected by chance alone. Finally, on southwest aspects, tulip appeared on lowland and downhill sites in numbers that were greater than could be attributed to chance alone. This was also the case for chestnut oak on uphill sites.

Table 5 indicates the interactions of species with slope position controlling for slope but considering all aspects simultaneously. This interaction was found significant on all slopes. Significance on the light slopes was due, in part, to the fact that there were more tulip on both lowland and downhill sites and more chestnut oak on both uphill and ridgetop sites than would be expected by random chance alone. On moderate slopes, the same was true except that chestnut oak occurred only on uphill sites in numbers greater than one could attribute solely to random chance. On steep slopes, tulip was represented on downhill sites in numbers greater than one would predict by random chance, while on uphill and ridgetop positions, chestnut oak was so represented.

Table 6 shows interactions of species with aspect considering all slopes but controlling for individual slope positions. This interaction is significant on all slope positions. On lowland positions, tulip was proportioned on all three aspects in numbers very close to those accountable by random chance. Chestnut oak was found on northwest aspects in numbers greater than can be accounted for by random chance. On downhill and uphill positions, tulip was found on southeast and southwest aspects and chestnut oak on southwest aspects both in numbers greater than can be accounted for by random chance. Finally, on ridgetop sites, tulip was found on northwest aspects and chestnut oak on southeast aspects both in numbers larger than can be accounted for by random chance.

Table 7 shows the significant interactions of species with slope considering all aspects but controlling for individual slope positions. This interaction is significant on all but downhill slope positions. On lowland positions, tulip was sampled on light and moderate slopes and chestnut oak on moderate slopes in numbers greater than one could attribute to random chance. On uphill slope positions, tulip was present on moderate slopes and chestnut oak on moderate and steep slopes in numbers larger than can be attributed to chance alone. Finally, on ridgetop sites, tulip was found on light slopes and chestnut oak on steep slopes both in quantities greater than can be accounted for by chance.

Table 8 indicates the significance of species-aspect interactions considering all slope positions and controlling individually for slope. The only significant interaction was on moderate slopes. In this case, there were more tulip than would be expected on northwest and southeast slopes. There were more chestnut oak on northwest and southwest aspects than could be attributed to random chance alone.

Table 9 shows the significant interactions of species with slope, considering all slope positions simultaneously but controlling for aspect. This interaction was significant on northwest and southeast aspects. On northwest aspects, tulip was sampled in numbers very close to those that would be expected by random chance. Chestnut oak was represented on moderate slopes in numbers greater than would be expected by random chance alone. On southeast aspects, tulip was sampled on moderate slopes in greater amounts than would be expected by random chance. Chestnut oak was found on light slopes in only a slightly greater amount than one would expect by random chance.

Table 10 shows the significance for the interaction of species with each individual variable, considering all values of the other two variables simultaneously. The interactions of species with slope, species with slope position, and species with aspect are all significant. The significance of the species-slope position interaction was due, in part, to the fact that there were more tulip on both lowland and downhill positions than would be expected by chance alone. The significance of the species-slope interaction can be partly attributed to the fact that there were more tulip on light and moderate slopes and more chestnut oak on moderate and steep slopes than would be expected by random chance alone. Finally, the species-aspect interaction was significant partly because there were more tulip on northwest and southeast aspects and more chestnut oak on southwest aspects than could be attributed to random chance alone.

Species with Slope Position Interaction.

ASPECT								
NW			SW			SE		
slope			slope			slope		
light	mod.	steep	light	mod.	steep	light	mod.	steep
*	N/A	N/A	*	*	N/A	N/A	*	*

Table 1

Note: * indicates that the interaction was significant at the 5% level

NO indicates that the interaction was not significant at the 5% level

N/A indicates that there was insufficient data for a Chi-square analysis

Species with Slope Interaction

ASPECT											
NW				SW				SE			
slope position				slope position				slope position			
LOWLAND	DOWN-HILL	UP-HILL	RIDGE-TOP	LOW-LAND	DOWN-HILL	UP-HILL	RIDGE-TOP	LOW-LAND	DOWN-HILL	UP-HILL	RIDGE-TOP
*	N/A	N/A	N/A	N/A	NO	N/A	*	*	NO	*	NO

Table 2

Species With Aspect Interaction

SLOPE											
LIGHT				MODERATE				STEEP			
slope position				slope position				slope position			
LOW-LAND	DOWN-HILL	UP-HILL	RIDGE-TOP	LOW-LAND	DOWN-HILL	UP-HILL	RIDGE-TOP	LOW-LAND	DOWN-HILL	UP-HILL	RIDGE-TOP
NO	NO	N/A	*	*	*	*	*	N/A	N/A	N/A	*

Table 3

Species with Slope Position Interaction

(All Slopes)

ASPECT		
NW	SW	SE
*	*	*

Table 4

Species with Slope Position Interaction

(All Aspects)

SLOPE		
LIGHT	MODERATE	STEEP
*	*	*

Table 5

Species with Aspect Interaction

(All Slopes)

SLOPE POSITION			
LOWLAND	DOWNHILL	UPHILL	RIDGETOP
*	*	*	*

Table 6

Species with Slope Interaction

(All Aspects)

SLOPE POSITION			
LOWLAND	DOWNHILL	UPHILL	RIDGETOP
*	NO	*	*

Table 7

Species with Aspect Interaction

(All Slope Positions)

SLOPE		
LIGHT	MODERATE	STEEP
NO	*	NO

Table 8

Species with Slope Interaction

(All Slope Positions)

ASPECT		
NW	SW	SE
*	NO	*

Table 9

Species with Slope Position Interaction (All Slopes, All Aspects) *
Species with Slope Interaction (All Slope Positions, All Aspects) *
Species with Aspect Interaction (All Slope Positions, All Slopes) *

Table 10

DISCUSSION

Before an actual discussion of the results, it must be noted that the author is not implying that the three site variables considered in this study are the only ones which influence species occurrence, nor is he claiming that these are the three major influences. The choice to study slope, aspect, and slope position simply reflects the site factors which were most familiar to the author before the beginning of this project. They also are factors commonly referred to in the literature in reference to species abundance.

The results indicate to a general degree that there exist systematic relations between species occurrence and the three site variables. Table 10, as an overall indicator of these systematic relationships, serves to validate this point. When all seedlings sampled were analyzed in a single contingency table, general trends became obvious.

The first contingency table is given in Figure 1. This is a crosstabulation of species with slope position index. The top number in each cell is the total number of observations found on the various slope positions. The circled numbers are the expected Chi-square values; those that would by random chance alone. These values were figured according to the formula:

$$\text{Expected Chi-square Value} = \frac{\text{row total}}{\text{grand total}} \times \frac{\text{column total}}{\text{grand total}} \times \text{grand total.}$$

From this table it is obvious that there were a greater number of tulip sampled on both lowland and downhill slope positions than indicated by the expected Chi-square value. This observation is in agreement with the sites commonly associated with occurrence of tulip. In the northern segment of its range, where temperatures are limiting, yellow-poplar is usually found in valleys and stream bottoms (7). Chestnut oak, on the other hand, occurred on uphill slope positions in numbers greater than that indicated by the expected Chi-square value. This is also in accordance with the sites commonly associated with this species. The tree is typically found on upland, dry sites, especially in the Central States (8).

The second contingency table is given in Figure 2. It represents a crosstabulation of species with slope. Comparison of the observed values with the expected values indicates that tulip-poplar was present on light and moderate slopes in numbers slightly larger than would be expected by chance. This was also the case with chestnut oak on moderate and steep slopes. Again, observations do not present any surprising results. The abundant occurrence of tulip-poplar on sites of light and moderate slopes is explained in part by the fact that these slopes have relatively high moisture conditions. The abundance of chestnut oak on moderate and steep slopes is explained in part by the fact that such sites have low moisture conditions. Chestnut oak evidently has the ability to survive in such conditions and out-compete other species with propagules in that type of area. The results lend evidence to the belief that moisture regimes are critical in determining species distribution.

Figure 3 is a contingency table representing the crosstabulation of species with aspect. Observed values of tulip-poplar were larger than the expected values on both northwest and southeast aspects. For chestnut oak, observed values were larger than the expected values on southwest aspects. As a general rule, in the northern hemisphere, sites with southern aspects are commonly drier and hotter than other aspects. These conditions are due to greater incident solar radiation. Therefore, more tulip-poplar would be expected on the northerly facing aspects if the previously stated relation between this species and higher moisture regimes is indeed correct. By the same logic, more chestnut oak would be expected on the southerly facing aspects. Although this is not precisely what occurred, there are various possible explanations.

One such explanation may be related to the fact that there were no plots with northeastern aspects. Had there been such plots, the contingency table would have had four aspect classes instead of three. This may have caused differences in calculated expected values and possibly resulted in a different species being "overabundant" on a particular aspect.

Another possible explanation for the results of this crosstabulation might be based on an inappropriate grouping of the aspect degree values into aspect classes (such as southeast, southwest, etc.). Instead of following the pattern of 0 to 89 degrees being a northeastern aspect and 90 to 179 degrees being a southeastern aspect, etc., it may have been more appropriate to offset 45 degrees and consider apsects from 315 to 44 degrees as northern aspects, those from 45 to 124 degrees as eastern aspects, etc. Had this been done, results may have shown an abundance of tulip-poplar on southerly aspects in numbers greater than would be expected by chance, and possibly a representation of chestnut oak on northerly facing sites in numbers greater than one would predict by random chance alone.

When the relation between species and any of the three site variables was analyzed considering <u>all</u> values of the other two variables, the null hypothesis of no relation between species occurrence and that particular site characteristic was rejected in each case. In other words, all three of the variables studied were found to be related to species occurrence. But for more specific analyses in which values of certain variables were held constant, this hypothesis was accepted. The author was not able to determine any pattern concerning these insignificant Chi-square values. He can only speculate as to why such values were obtained.

In many instances, a greater amount of data may have produced more consistent results. A small number of observations in a given contingency table is more likely to produce aberrant results than a large number. Further, vacant columns or rows in a table reduce the degrees of freedom for testing the Chi-square statistic. This increases the chances that the statistic is significant at the 5% level.

In other instances, insignificant Chi-square values may be explained in a different way. On a site, the presence and survival of a particular species is the result of numerous environmental factors. Slope, aspect, and slope position are just three of these factors which influence the amount of actual resources available for plant growth. But the interactions and relative importance of these factors differ from site to site. It is these differences which may cause variations in the Chi-square values on different sites.

In conclusion, there is very little surprising information that can be derived from this study. There is evidence to suggest that all three site characteristics considered are systematically related to species occurrence on upland oak sites in southern Ohio. Tulip is favored on areas of higher moisture conditions such as those found on lowland and downhill slope positions and on areas of low to moderate slopes. Chestnut oak is favored on areas of lower moisture conditions such as those found on uphill slope positions and moderate to steep slopes. As regarding aspect, evidence was not consistent with that from other observations and studies, and further experimentation is needed.

BARNEBEY REGENERATION STUDY

FILE STUDY1 (CREATION DATE = 05/19/76) REGENERATION UNDER 3 FEET

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * *
SPECIES BY SPI (SLOPE POSITION INDEX)
* *

SPECIES	COUNT / ROW PCT / COL PCT / TOT PCT	SPI: LOWLAND 1	DOWNHILL 2	UPHILL 3	RIDGETOP 4	ROW TOTAL
TULIP	1	66	85	77	33	261
		46 25.3	77 32.6	83 29.5	76 12.6	21.8
		31.3	33.6	20.1	9.4	
		5.5	7.1	6.4	2.8	
CHESTNUT-OAK	2	37	47	135	89	308
		54 12.0	65 15.3	98 43.8	90 28.9	25.7
		17.5	18.6	35.2	25.4	
		3.1	3.9	11.3	7.4	
OTHER	3	108	121	171	228	628
		17.2	19.3	27.2	36.3	52.5
		51.2	47.8	44.6	65.1	
		9.0	10.1	14.3	19.0	
	COLUMN TOTAL	211	253	383	350	1197
		17.6	21.1	32.0	29.2	100.0

RAW CHI SQUARE = 90.23744 WITH 6 DEGREES OF FREEDOM. SIGNIFICANCE = 0.000

Figure 1

BARNEBEY REGENERATION STUDY

FILE STUDY1 (CREATION DATE = 05/19/76) REGENERATION UNDER 3 FEET

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * *
SPECIES BY SLOPE
* *

SPECIES	SLOPE: COUNT / ROW PCT / COL PCT / TOT PCT	LIGHT 1	MODERATE 2	STEEP 3	ROW TOTAL
TULIP	1	82	158	21	261
		(80) 21.4	(143) 60.5	(38) 8.0	21.8
		22.3	24.2	12.0	
		6.9	13.2	1.8	
CHESTNUT-OAK	2	77	169	62	308
		(95) 25.0	(168) 54.9	(45) 20.1	25.7
		20.9	25.8	35.4	
		6.4	14.1	5.2	
OTHER	3	209	327	92	628
		33.3	52.1	14.6	52.5
		56.8	50.0	52.6	
		17.5	27.3	7.7	
	COLUMN TOTAL	368	654	175	1197
		30.7	54.6	14.6	100.0

AW CHI SQUARE = 21.19235 WITH 4 DEGREES OF FREEDOM. SIGNIFICANCE = 0.000

Figure 2

BARNEBEY REGENERATION STUDY

FILE STUDY1 (CREATION DATE = 05/19/76) REGENERATION UNDER 3 FEET

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * *
SPECIES BY ASPECT
* *

SPECIES	ASPECT COUNT ROW PCT COL PCT TOT PCT	NORTHWEST QTR 1	SOUTHEAST QTR 2	SOUTHWEST QTR 3	ROW TOTAL
TULIP	1	88 78 33.7 24.5 7.4	90 62 34.5 31.8 7.5	83 121 31.8 15.0 6.9	261 21.8
CHESTNUT-OAK	2	83 93 26.9 23.1 6.9	61 73 19.8 21.6 5.1	164 143 53.2 29.5 13.7	308 25.7
OTHER	3	188 29.9 52.4 15.7	132 21.0 46.6 11.0	308 49.0 55.5 25.7	628 52.5
	COLUMN TOTAL	359 30.0	283 23.6	555 46.4	1197 100.0

RAW CHI SQUARE = 34.93712 WITH 4 DEGREES OF FREEDOM. SIGNIFICANCE = 0.000

Figure 3

ANALYSIS OF HONORS PROJECT

I have mixed feelings concerning this honors project. I am extremely disappointed with the report as a peice of literature benefiting the scientific community. As such, it is nearly worthless. The information derived from the data has not been undiscovered thus far. No new information can be offered; only a confirmation of previously accepted ideas. Regardless of the novelty of the information contained herein, the form in which the information is presented is also worthless. For example, there is no forest manager who would benefit in his profession by reading the "Results" portion of this paper. Further, the information presented in the "Discussion" section is nothing more than what is quickly available in the Forest Service handbook, Silvics of Forest Trees of the United States.

To do this project a second time would involve numerous major changes. The data collection phase would be undertaken only after I had a thorough understanding of the type of statistical analysis that would be incorporated. I would probably work towards the formulation of a regression equation from which one could predict the numbers of chestnut oak and tulip seedlings coming in by knowing slope, aspect, and slope position. The experiment would be designed such that adequate data would be available to construct such a workable model. This model would be more useful to forest managers in that it might reduce the uncertainity concerning adequate regeneration following a clearcutting operation. Also, whereas my original intention in this project was to study all species present, I did not realize the immensity of such an undertaking. An extremely large number of sample plots would have been required to derive information concerning all the tree species on the study area. Thus, I was forced to restrict myself to the two most abundant, and possibly the most important, species on the area.

Concerning the project as a whole, I am fairly pleased with the knowledge and experience that I have gained. I have become aware of the importance of proper planning previous to actually stepping out into the field. Further, I have realized the significance of a well-written project proposal in helping to further plan and solidify vague concepts concerning implementation of the project. Finally, I have gained a realization of the complex nature of ecosystems. Such an understanding could have been arrived at in no other way than by undertaking a study such as this.

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